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Fig.1.

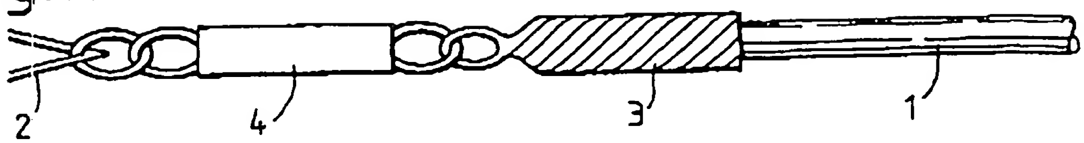


Fig.2.

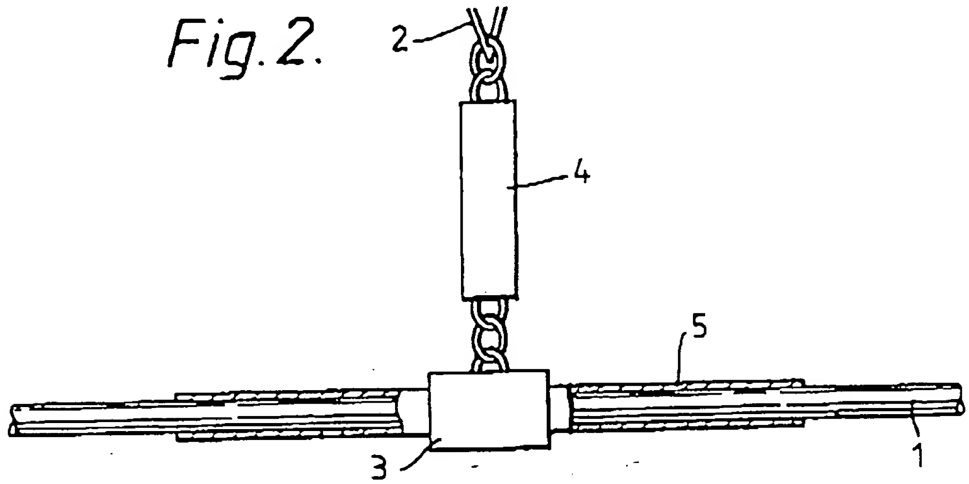


Fig.3.

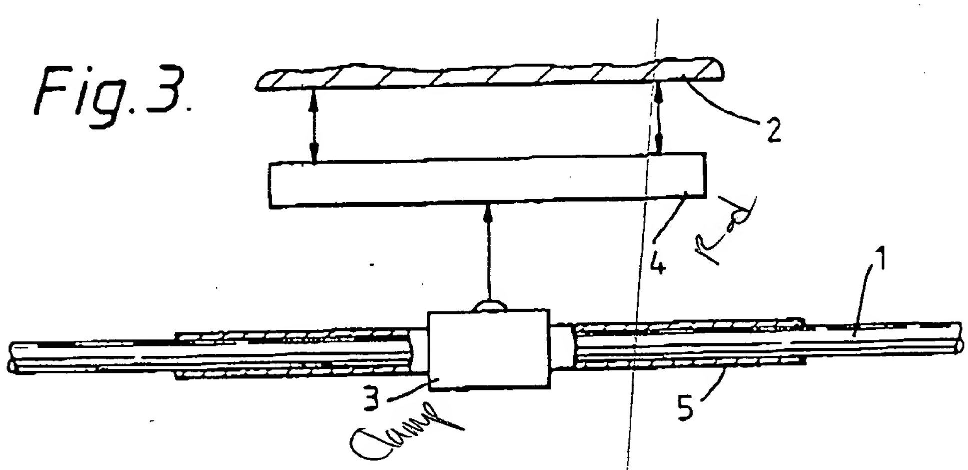
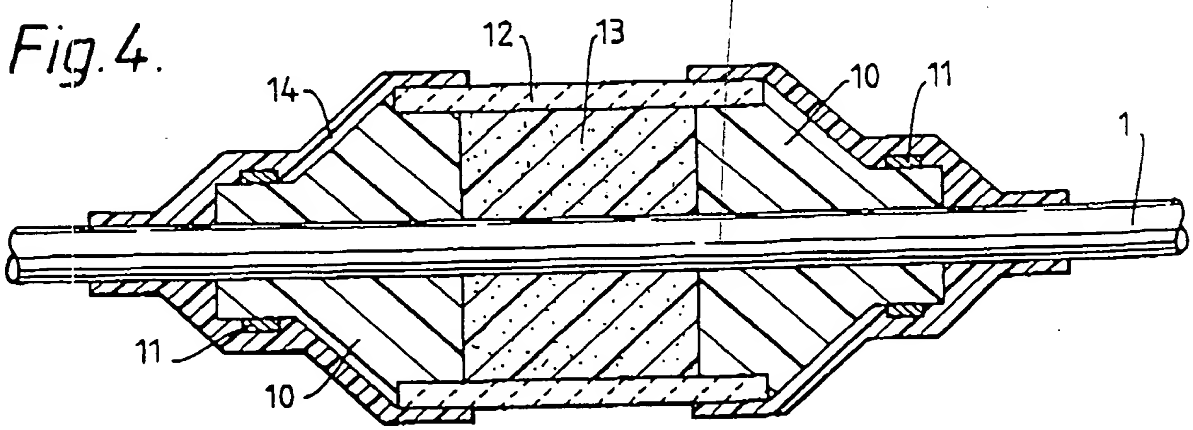


Fig.4.



OVERHEAD OPTICAL TRANSMISSION SYSTEM

This invention relates to an overhead optical transmission system in which one or more than one optical cable comprising at least one optical fibre and an overall protective sheath of electrically insulating material is freely supported in lengths between for example towers or masts, spaced along the route of the system.

In an overhead optical transmission system of this kind, it is the general practice to secure each end of the or each long length of optical cable to a tower, mast or other upstanding support by means of a termination fitting of metal or metal alloy which surrounds and is clamped or otherwise secured on a part of the length of optical cable at or near the cable end or to suspend the or each long length of optical cable at a position intermediate of its ends from an upstanding support by means of a fitting of metal or metal alloy which surrounds and is clamped or otherwise secured on an intermediate part of the length of optical cable.

When the supports also suspend overhead electric power lines currents can be capacitively induced on the surface of the optical cable, the magnitude of which will be greatest in the proximity of the supports. Under wet conditions ohmic heating of the cable surface by the induced currents can cause a short length of the cable surface to become dry, whereupon dry-band arcing may occur at this point on the cable which can cause

degradation of the sheath. The severity of such degradation might be related to any mechanical stress to which the sheath of the optical cable is subjected. the optical cable sheath can occur at or near this end of each metal fitting on the cable.

It is an object of the present invention to provide an improved overhead optical transmission system in which risk of degradation of the insulating sheath of the or each optical cable in the region of said end of each metal fitting is substantially reduced.

According to one aspect, the present invention provides an overhead optical transmission system in which at least one optical cable comprising at least one optical fibre and an overall protective sheath of electrically insulating material is freely suspended in lengths by upstanding supports which also suspend one or more electric transmission lines, wherein the system includes, between the optical cable and each support and/or surrounding the optical cable in the region of each support, an element having an exposed circumferentially continuous surface of a material that is less hydrophilic than the exposed surface of the insulating sheath of the optical cable, so that any dry band arcing that may occur in the system will occur preferentially at the exposed surface of the element.

By virtue of the provision at or near each tower by which the optical cable is supported of a limited length of an exposed circumferentially continuous surface of a material which is substantially less hydrophilic than the exposed surface of the insulating sheath of the optical cable, any dry band arcing that may arise will be encouraged to occur on said exposed circumferentially continuous surface so that the risk of degradation due to dry band arcing of the insulating sheath of the optical cable, especially in the region of each metal fitting, is substantially reduced.

The material forming the protective sheath of the optical cable is stated as being "electrically insulating" by which is meant that its resistivity is such that the optical cable as a whole has sufficient linear resistance to allow dry-band arcing to occur.

Where the element having the exposed circumferentially continuous surface of said material is disposed between the optical cable and a support by which the cable is suspended, preferably it is at least a part of the exposed surface of an elongate member interconnected between the metal fitting surrounding and secured to the cable and the support. In this case, preferably the elongate member comprises a rod or sleeve whose exposed surface at least in part constitutes said

exposed circumferentially continuous surface. Where an end of an optical cable is secured to a support, the rod or sleeve preferably is interconnected end-to-end between the metal terminal fitting and the support; where an intermediate part of a length of optical cable is suspended from a support, the rod or sleeve may be interconnected end-to-end between the metal fitting secured to said intermediate part of the cable length and the support or it may be so interconnected therebetween that the rod or sleeve extends lengthwise with respect to the optical cable.

In an alternative arrangement, the element may be in the form of a sleeve that surround the optical cable, each end of the sleeve having a substantially fluid-tight seal with the optical cable.

The sleeve preferably is of such an internal diameter that it is radially spaced from the optical cable throughout its periphery, the space between the sleeve and the optical cable being substantially filled with one or more preformed bodies or a composition of electrically insulating material applied over or assembled around the optical cable. The substantially fluid-tight seal at each end of the sleeve, preferably is effected by tape or a preformed collar of electrically semi-conductive material bonded or

otherwise secured to the sleeve and to the insulating sheath of the optical cable. For ease of assembly, the sleeve may be slit throughout its length or may be built up of two preformed shells, each of approximately semi-annular cross-section; in this case, when assembling the sleeve, the slit will be positioned beneath the optical cable and sealed, or the sealed joints between the shells will be on opposite sides of and approximately level with the axis of the cable, to reduce risk of moisture penetration into the sleeve. In another form, one shell part may form a larger sector than the other. Such an arrangement has the advantage that the smaller shell part may be positively engaged with the larger one. The sleeve is preferably located in the region of 30cm to 1m from the point at which the cable is suspended (the fitting).

Whatever the form of the element, the exposed circumferentially continuous surface should have an axial length that is greater than the length of a dry band arc, for example at least 3cm and preferably at least 5cm and especially at least 10cm. There is no limit to the maximum length although for general convenience and cost, the surface will not usually be longer than 30cm. Also, in general it is preferred for the circumference of the circumferentially continuous surface to be as small as possible, for example it may, in some cases be less than twice that of the optical

cable or even smaller than that of the optical cable, in order to increase the induced current surface density at that region.

Clearly the element should not be electrically conductive along its entire length since this would prevent arcing, and, in the case of elements located between the cable and support, should have sufficient mechanical strength to support the cable. Preferably the element is formed at least partly from a ceramic or vitreous material.

The limited length of exposed circumferentially continuous surface of a material which is substantially less hydrophilic, and hence substantially more hydrophobic, than the surface of the insulating sheath of the optical cable will tend to dry and/or shed any moisture that may settle on it before any portion of the insulating sheath of the optical cable dries and/or sheds any moisture on it with the result that any dry-band arcing that may occur will do so on said exposed circumferentially continuous surface, thereby substantially reducing risk of degradation of the insulating cable sheath due to dry band arcing. The extent to which the circumferentially continuous surface of the element is more hydrophobic than the optical cable sheath is best quantified in terms of the surface resistivity. Preferably the surface of the element is sufficiently hydrophobic that its surface resistivity under moist conditions is at least twice, and especially

at least ten times that of the insulating sheath of the optical cable.

In order to prevent the surface of the element becoming less hydrophobic after weathering it may be appropriate for the element to have a replaceable surface layer of a hydrophobic composition, for example a grease, or a silicone rubber sheath which can be renewed every few years.

If desired, the element may be connected in parallel with a voltage limiting device, for example it may have at or near the ends of the limited length of the exposed circumferentially continuous surface arcing horns which will serve to raise arcs off this surface as they grow in length. As is known a number of such voltage limiting devices can be connected in series. In addition or alternatively the element may be designed so that one or more physical and/or electrical discontinuities are provided on the surface to promote the formation of dry bands at particular points.

According to another aspect, the invention provides an overhead optical transmission system in which at least one optical cable comprising at least one optical fibre and an overall protective sheath of electrically insulating material is freely supported in long lengths by towers, masts or other upstanding supports employed to support overhead electric transmission lines and spaced along the route of the

system and in which each end of a length of optical cable is secured to a tower, mast or other upstanding support by means of a termination fitting of metal or metal alloy which surrounds and is clamped or otherwise secured on a part of the length of the optical cable at or near said end or an intermediate part of a length of optical cable is suspended from a tower, mast or other upstanding support by means of a fitting of metal or metal alloy which surrounds and is clamped or otherwise secured on said intermediate part of the cable length, wherein a limited length of an exposed circumferentially continuous surface of a material which is substantially less hydrophilic than the exposed surface of the insulating sheath of the optical cable is disposed between the optical cable and each tower by which the cable is supported and/or surrounds the optical cable at a position immediately adjacent or close to the metal fitting by means of which the optical cable is secured to or suspended from said tower.

The invention is further illustrated, by way of example, by the accompanying informal drawing which shows four alternative arrangements for reducing risk of degradation due to dry band arcing of the insulating sheath of an optical cable supported by the towers of an overhead electric transmission system in which drawing:-

Figure 1 is a diagrammatic representation of an arrangement in which a ceramic rod is interconnected

end-to-end between a metal terminal fitting on an optical cable and a tower;

Figure 2 is a diagrammatic representation of an arrangement in which a ceramic rod is interconnected end-to-end between a metal fitting secured to an intermediate part of an optical cable and a tower;

Figure 3 is a diagrammatic representation of an arrangement in which a ceramic rod is so interconnected between a metal fitting secured to an intermediate part of an optical cable and a tower that the rod extends lengthwise with respect to the cable, and

Figure 4 is a diagrammatic sectional side view of a ceramic sleeve surrounding an optical cable at a position immediately adjacent or close to a metal fitting (not shown).

Referring to the accompanying drawings, Figure 1 shows schematically an optical fibre cable 1 suitable for transmission of light having a wavelength within the range of 0.8 to 2.1 micrometres, which is terminated at a tower 2 part only of which is shown by means of a conventional metal clamp 3. A ceramic rod 4 is interposed between the clamp 3 and the tower and is provided with a thin skin (not shown) of hydrophobic grease.

Figure 2 shows schematically an intermediate part of an optical fibre cable 1 which is suspended from a tower 2 by means of a clamp 3 that encircles the cable,

and a ceramic rod 4 that supports the clamp from the tower. Reinforcing rods 5 may be provided that extend out of each side of the clamp and surround the cable in order to relieve mechanical stresses on the cable in the region of the clamp 3.

An alternative arrangement is shown in Figure 3 for suspending an intermediate part of an optical fibre cable. This arrangement is as shown in Figure 2 with the exception that the clamp 3 and the tower 2 are not attached to the ends of the ceramic rod 4 but instead both ends thereof are attached to the tower and the optical fibre cable 1 is suspended from the mid-point of the rod.

In each of these arrangements the tower will also carry high voltage electrical lines, with the result that a current will be capacitively induced on the surface of the optical cable. The induced current will flow to ground (the tower) via the ceramic rod 4 and the clamp 3. In wet conditions the surface of the rod 4 which is substantially less hydrophilic than that of the sheath of the optical cable 1 will shed water faster than the surface of the cable 1 with the result that its surface resistivity will be considerably higher than that of the cable for example by an order of magnitude. The relatively higher ohmic heating of the induced currents on the ceramic rod 4 will cause the remaining moisture to evaporate, with the result that dry-band

arcing will occur on the surface of the rod rather than on the cable sheath.

Figure 4 shows an alternative form of element which may be located about the cable 1. The element comprises a pair of generally frusto conical mouldings 10 which may each be formed as a pair of separate halves for installation, and which are clamped on the optical cable by means of clamps 11. The mouldings 10 are spaced apart axially on the cable by about 20cm, and a pair of ceramic half pieces are positioned over the cable to form a cylinder 12 that bridges the gap between the mouldings 10. An insert 13 may be provided under the ceramic cylinder. The exposed surfaces of the mouldings 10 are formed from a semiconductive material 14 in order to relieve electrical stresses on the assembly, and the exposed surface of the ceramic cylinder 12 may, as mentioned above, be coated with a hydrophobic grease.

Two such element will be installed on the optical cable in the region of each tower, one on each side of the tower.

CLAIMS:

1. An overhead optical transmission system in which at least one optical cable comprising at least one optical fibre and an overall protective sheath of electrically insulating material is freely suspended in lengths by upstanding supports which also suspend one or more electric transmission lines, wherein the system includes, between the optical cable and each support and/or surrounding the optical cable in the region of each support, an element having an exposed circumferentially continuous surface of a material that is less hydrophilic than the exposed surface of the insulating sheath of the optical cable, so that any dry band arcing that may occur in the system will occur preferentially at the exposed surface of the element.

2. A system as claimed in claim 1, wherein the elements are located between the optical cable and the supports.

3. A system as claimed in claim 2, wherein each element comprises an elongate rod that is interconnected end-to-end between the support and a metal fitting that is secured to the optical cable.

4. A system as claimed in claim 1, wherein each element surrounds the optical cable and is in the form of a sleeve, each end of which has a substantially fluid-tight seal with the optical cable.

5. A system as claimed in claim 4, wherein each element is located on the cable at a distance of from

30cm to 1m the point at which the cable is suspended from the support.

6. A system as claimed in any one of claims 1 to 5, wherein the exposed circumferentially continuous surface of each element has an axial length of at least 3cm.

7. A system as claimed in any one of claims 1 to 6, wherein the exposed circumferentially continuous surface of each element has a surface resistivity that is at least twice the surface resistivity of the insulating sheath of the optical cable.

8. A system as claimed in claim 7, wherein the surface resistivity of each element is at least ten times that of the insulating sheath of the optical cable.

9. A system as claimed in any one of claims 1 to 8, wherein each element is formed at least partly from a ceramic or vitreous material.

10. A system as claimed in any one of claims 1 to 9, wherein each element has a replaceable surface layer of a hydrophobic composition.

11. An overhead optical transmission system substantially as hereinbefore described with reference to, and as shown in, any one of the accompanying drawings.

12. An overhead optical transmission system in which at least one optical cable comprising at least one optical fibre and an overall protective sheath of

electrically insulating material is freely supported in long lengths by towers, masts or other upstanding supports employed to support overhead electric transmission lines and spaced along the route of the system and in which each end of a length of optical cable is secured to a tower, mast or other upstanding support by means of a termination fitting of metal or metal alloy which surrounds and is clamped or otherwise secured on a part of the length of the optical cable at or near said end or an intermediate part of a length of optical cable is suspended from a tower, mast or other upstanding support by means of a fitting of metal or metal alloy which surrounds and is clamped or otherwise secured on said intermediate part of the cable length, wherein a limited length of an exposed circumferentially continuous surface of a material which is substantially less hydrophilic than the exposed surface of the insulating sheath of the optical cable is disposed between the optical cable and each tower by which the cable is supported and/or surrounds the optical cable at a position immediately adjacent or close to the metal fitting by means of which the optical cable is secured to or suspended from said tower.